



# TENNESSEE DEPARTMENT OF EDUCATION

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## Greenhouse Management

<b>Primary Career Cluster:</b>	Agriculture, Food and Natural Resources
<b>Consultant:</b>	Steven Gass, (615) 532-2847, <a href="mailto:Steven.Gass@tn.gov">Steven.Gass@tn.gov</a>
<b>Course Code(s):</b>	5954
<b>Prerequisite(s):</b>	<i>Principles of Plant Science and Hydroculture</i> (6119)
<b>Credit:</b>	1
<b>Grade Level:</b>	11
<b>Graduation Requirements:</b>	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
<b>Programs of Study and Sequence:</b>	This is the third course in the <i>Horticulture Science</i> program of study.
<b>Aligned Student Organization(s):</b>	FFA: <a href="http://www.tnffa.org">http://www.tnffa.org</a> Allie Ellis, (615) 253-5207, <a href="mailto:Allie.Ellis@tn.gov">Allie.Ellis@tn.gov</a>
<b>Coordinating Work-Based Learning:</b>	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, Teachers are encouraged to use embedded WBL activities. For information, visit <a href="http://tn.gov/education/cte/work_based_learning.shtml">http://tn.gov/education/cte/work_based_learning.shtml</a> .
<b>Available Student Industry Certifications:</b>	Worker Protection Standard (WPS) for Agricultural Pesticides
<b>Dual Credit or Dual Enrollment Opportunities:</b>	A statewide dual credit challenge examination exists for this course for students to earn dual credit at Tennessee public postsecondary institutions that offer agriculture. For more information, please visit <a href="http://www.tn.gov/education/opca/">http://www.tn.gov/education/opca/</a> .
<b>Teacher Endorsement(s):</b>	048, 150, 448
<b>Required Teacher Certifications/ Training:</b>	While not required to teach the course, teachers who use a greenhouse facility or an outdoor lab (cold frame, nursery, etc.) that uses any type of chemical (with an EPA label) must have the Commercial Pesticide Applicators License for C10 and C15.
<b>Teacher Resources:</b>	<a href="http://www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml">http://www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml</a>

### Course Description

*Greenhouse Management* is an applied-knowledge course designed to prepare students to manage greenhouse operations. This course covers principles of greenhouse structures, plant health and growth, growing media, greenhouse crop selection and propagation, and management techniques. Upon completion of this course, proficient students will be equipped with the technical knowledge and skills needed to prepare for further education and careers in horticulture production. Greenhouse Management is a dual credit course with statewide articulation. Standards in this course are aligned

with Tennessee State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee State Standards in Mathematics, and Tennessee state standards for Biology I and Biology II, as well as National Agriculture, Food and Natural Resources Career Cluster Content Standards.\*

## **Program of Study Application**

This is the third course for the *Horticulture Science* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food and Natural Resources website at

<http://www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml>.

## **Course Standards**

### **Greenhouse Industry Introduction**

- 1) Analyze the global nature of the horticulture industry and assess the economic impact and technological advancements associated with greenhouse production practices. Create a timeline to summarize the history and development of the greenhouse production industry, citing specific textual evidence. (TN Reading 1, 2; TN Writing 4)
- 2) Accurately maintain an activity recordkeeping system and apply proper financial recordkeeping skills as they relate to a greenhouse industry. Demonstrate the ability to analyze records by generating reports and completing related applications (i.e., employment application, efficiency reports, SAE applications, and profit and lost statements). (TN Reading 9; TN Writing 2, 9)
- 3) Apply the concepts of occupational safety and industry safety prevention and control standards by interpreting information from industry manuals.
  - a. Assess the purpose of worker protection standards and obtain the worker protection standards student industry certification.
  - b. Review common laboratory safety procedures for tool and equipment operation in horticulture laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy.(TN Reading 3)

### **Greenhouse Design, Construction, and Components**

- 4) Describe characteristics of successful greenhouses and create a list of factors for planning and designing greenhouse facilities. Factors must include physical location, market potential, utilities, climatic conditions, and production goals. (TN Writing 4)
- 5) Classify greenhouse structures by comparing and contrasting greenhouse construction materials, including but not limited to frames, coverings, and glazing materials. Justify selection of greenhouse construction materials based on cost effectiveness, stability, maintenance, and function. (TN Reading 8, 9; TN Writing 9)
- 6) Create an annotated model representing research-based practices in greenhouse planning and design and justify the process outlined in the model. The design must include at least the

following items: structure materials, layout, lighting, bench arrangements, traffic flow, and physical location. (TN Reading 7; TN Writing 4, 8)

- 7) Compare general maintenance and upkeep requirements for a variety of greenhouses in relation to the type of structure and associated systems. Create a checklist of prescribed maintenance, preventative maintenance, monitoring, and troubleshooting schedules for greenhouse facilities and equipment. Demonstrate the mechanical skills needed for the general maintenance and repair of greenhouses and associated systems (such as basic wiring, plumbing, and general construction). (TN Reading 2, 3; TN Writing 4, 8)

### **Growing Media**

- 8) Compare and contrast the attributes of growing mediums. Write an informative essay to describe the major components of soil, and identify basic physical and chemical characteristics of soil including structure and texture. (TN Reading 9; TN Writing 2)
- 9) Identify and provide written justification to describe the effects of soil and soilless composition (pH, organic matter content, and mineral content) on plant health and growth. Perform basic soil sampling and testing techniques and interpret test data to formulate corrective actions as needed. (TN Reading 1, 3; TN Writing 7, 9; TN Math S-ID)
- 10) Explain the principles of media preparation; develop a check sheet to guide media preparation. Describe the purpose, methods, and importance for sterilizing media. Compare and contrast the cost effectiveness of premix and personal mix media to soil media. (TN Reading 7; TN Writing 8)

### **Plant Structure, Function, and Growth**

- 11) Apply concepts of scientific taxonomy and industry-specific terminology in distinguishing different species and types of plants. Create a visual chart, brochure, or fact sheet that identifies common plant species used in greenhouse production by classification, care, and use. (TN Reading 4)
- 12) Research the basic plant structure components and create an illustrative plant model to identify and differentiate among components. Demonstrate a working knowledge of plant physiology, including:
  - a. The relationship between form and function for major plant structures
  - b. The anatomical and physiological differences of specific plant species(TN Biology II 7)
- 13) Select relevant technical information to analyze and support claims regarding the relationships between light, temperature, and water on plant growth. Draw conclusions about the interrelationships between plant life processes (such as photosynthesis, respiration, and transpiration), plant growth, and maintenance. (TN Reading 8; TN Biology I 2; TN Biology II 7)
- 14) Compare and contrast current industry approved methods to regulate plant growth including, but not limited to, environmental, physical, genetic and chemical. Demonstrate in a live setting or in a presentation the ability to apply the best growth regulator to specific plants to obtain selected outcomes. (TN Reading 3, 8, 9; TN Biology II 7)

## **Plant Nutrition**

- 15) Analyze the nutrient requirements of plants and assess the importance of the 17 essential plant nutrients for plant health. Identify the chemical and biological processes needed to make nutrients available for growth and maintenance, and distinguish among nutrient deficiency and toxicity signs and symptoms in plants. (TN Biology II 7)
- 16) Research case studies to cite specific textual evidence determining the significance of safety hazards associated with fertilizer use. In an informative essay, justify the use of different precautions for the prevention or management of hazards and evaluate the efficacy of prevention measures. (TN Reading 1, 8, 9; TN Writing 2, 4, 7, 9)
- 17) Identify the basic types of fertilizers and their applications for greenhouse production crops. Differentiate the effects of fertilizer ratios on plant growth and health to hypothesize possible outcomes of each ratio. Calculate proper formulations of fertilizers based upon label directions using systems of equations. Demonstrate in a live setting or in a presentation the ability to follow fertilizer label procedures precisely as they pertain to selection, handling, application, storage, and disposal. (TN Reading 3; TN Math N-Q, A-CED)

## **Plant Propagation**

- 18) Differentiate between the methods of sexual and asexual plant propagation by summarizing valid research. Compare and contrast the different techniques of propagation, explaining advantages and disadvantages of each in an informative text. Conduct at least the following: cutting, budding, layering, sowing, germination rate calculation, and seed viability. (TN Reading 2, 8; TN Writing 4, 9)

## **Environmental Control Systems**

- 19) Assess the procedures required for producing multiple commercial plant species in a controlled environment, and apply these procedures to produce a variety of specific greenhouse crops. Evaluate environmental factors that affect greenhouse crops to justify management methods. (TN Reading 2; TN Writing 4)
- 20) Evaluate the greenhouse climate and recommend the proper climate control equipment to maintain an optimum growing climate, including but not limited to ventilation, humidifiers, heating, cooling, and shading. Provide written justification for each recommendation. (TN Writing 1, 4).
- 21) Demonstrate effective methods to meet water requirements for healthy plant growth. Examine and explain how water pH influences plant growth. Research from multiple technical texts the function and operating principles of greenhouse irrigation systems (such as misting, drip, and overhead systems) to meet watering requirements for the purposes of maintaining optimum moisture level for a variety of plants. (TN Reading 3; TN Writing 8; TN Biology II 7)

## **Diseases, Disorders, and Pests**

- 22) Determine the economic and aesthetic impact of plant diseases, disorders, and pests. Identify and diagnose the symptoms of common plant diseases, disorders, and pests, and summarize methods of prevention, treatment, and control by drawing evidence from informational texts and relevant scientific literature. (TN Writing 2, 9; TN Biology II 7)
- 23) Identify the types of pesticides and their applications for greenhouse production. Research the safety hazards associated with pesticide use for multiple greenhouse pesticides. Calculate proper formulations of pesticides based upon label directions for specific pests by creating systems of equations that describe numerical relationships. (TN Reading 1; TN Writing 1, 4, 7, 9; TN Math N-Q, A-CED)
- 24) Demonstrate in a live setting or in a presentation the ability to follow pesticide procedures precisely according to label and safety guidelines, including selection, handling, personal protective equipment (PPE), application, storage, and disposal. (TN Reading 3)
- 25) Evaluate the basic principles and assess the overall effectiveness of integrated pest management (IPM) for controlling greenhouse pests and diseases. Compare with traditional chemical controls.

### **Hydroponic Applications**

- 26) Examine the roles of hydroponic systems in greenhouse crop production. Describe essential elements of hydroponic systems; explore recent trends and advancements to design a hydroponic system for a specific greenhouse crop. (TN Reading 7; TN Writing 8)
- 27) Apply basic principles of hydroponics to compare hydroponic and soil-based growing methods for providing nutrients to plants. Summarize the advantages and disadvantages of using soilless media systems to evaluate the efficacy for specific crops. (TN Reading 7; TN Writing 8)

### **Greenhouse Business Management**

- 28) Debate laws and regulations affecting horticulture businesses. Demonstrate the use of general business and recordkeeping skills necessary to manage a horticultural business, including but not limited to marketing, advertising, product displays, scheduling, inventory control, merchandise handling and profit and loss statements. (TN Reading 1, 9; TN Writing 2, 9)
- 29) Research, develop, and implement greenhouse production schedules for a representative sampling of greenhouse crops that includes at least the following: plant selection, plant material cost (seed, plug, cuttings), growth media, fertilizers, water, testing kits, pricing guides, profit margin, labor, and other expenses. (TN Reading 3; TN Writing 4; TN Math S-ID, Modeling)

### **Standards Alignment Notes**

\*References to other standards include:

- TN Reading: [Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).

- Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standards 5, 6, and 10 at the conclusion of the course.
- TN Writing: [Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
  - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.
- TN Math: [Tennessee State Standards for Mathematics](#); Math Standards for High School: Number and Quantity, Algebra, Modeling, Statistics and Probability.
  - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or collaborate on lesson planning. Students who are engaging in activities listed above should be able to demonstrate quantitative, algebraic, and statistical reasoning as applied to specific technical concepts. In addition students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- SAE: [Supervised Agricultural Experience](#): All Agriculture students are encouraged to participate in a Supervised Agricultural Experience program to practice and demonstrate the knowledge and skills learned in their agriculture courses.
- TN Biology I: Tennessee Science: [Biology I](#) standard 2 may provide additional insight and activities for educators.
- TN Biology II: Tennessee Science: [Biology II](#) standard 7 may provide additional insight and activities for educators.
- AFNR: [National Agriculture, Food and Natural Resources \(AFNR\) Career Cluster Content Standards](#): Students engaged in activities outlined above should be able to demonstrate fluency in Standards ABS.03, ABS.07, CS, PS.01, PS.02, and PS.03 at the conclusion of the course.
- P21: Partnership for 21st Century Skills [Framework for 21st Century Learning](#)
  - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.